

C-A OPERATIONS PROCEDURES MANUAL

15.2.12 Lockout/Tagout Procedure for RHIC Main Magnet Power Supplies

1. Purpose

- 1.1. The purpose of this procedure is to provide instructions in how to perform the Lockout/Tagout (LOTO) of the RHIC Main Magnet Power Supplies (RMMPS). Access to different equipment requires locking out different power sources. Perform ONLY the section specified when accessing the listed equipment.
- Refer to section 5.2 for access to:
 - a ring;
 - a valve box;
 - the Interaction Region Power Supplies (IRPS) on the main power supply circuits;
 - a RMMPS Power Module (PM) 480 V_{AC} compartment;
 - a RMMPS PM SCR compartment;
 - any of the Output Circuit Compartment (OCC) compartments EXCEPT the Hot Box or the Cold Box.
 - Refer to section 5.3 for access to the OCC Hot Box.
 - Refer to section 5.4 for access to the OCC Cold Box.
- 1.2. There are four RMMPS: one for the Yellow Quad Ring, one for the Yellow Dipole Ring, one for the Blue Quad Ring, and one for the Blue Dipole Ring. Each RMMPS has one Flat-Top Power Module (FTPM), one Ramp Power Module (RPM), one Output Circuit Compartment (OCC), and one Energy Dump Resistor Enclosure (EDRE). The maximum ratings of the RMMPS are given in Table 1.

Table 1

Maximum Output Ratings for RMMPS

<u>Power Supply</u>	<u>Voltage</u>	<u>Current</u>
Yellow Quad	90 V _{DC}	5500 A _{DC}
Yellow Dipole	400 V _{DC}	5500 A _{DC}
Blue Quad	90 V _{DC}	5500 A _{DC}
Blue Dipole	400 V _{DC}	5500 A _{DC}

- 1.3 All the RMMPS are located in service building 1004B.
- 1.4 This procedure is to be performed only by persons authorized, as described in Paragraph 2.

2. **Responsibilities**

- 2.1 The list of persons authorized to perform these steps, and documentation of the requisite training and credentials, will be maintained by the Power Supply Systems Section Head, and reviewed at least annually.

3. **Prerequisites**

- 3.1 All personnel working on any electrical system or equipment in the C-AD shall be familiar with BNL [SBMS Electrical Safety](#), BNL [SBMS Lockout/Tagout \(LO/TO\)](#), [C-A-OPM 1.5, “Electrical Safety Implementation Plan”](#), [C-A-OPM 1.5.3 “Procedure to Open or Close Breakers and Switches and Connecting/Disconnecting Plugs”](#), [C-A-OPM 2.36, “Lockout/Tagout for Control of Hazardous Energy”](#). C-AD will provide on-site/work specific training to individuals in the electrical safety aspects of their job functions and assignments.
- 3.2 Personnel performing this procedure shall be authorized by the Power Supply Systems Section Head. The authorization shall be renewed yearly, and anytime the Power Supply Systems Section Head sees the need.
- 3.3 Only persons with current training in BOTH authorized LOTO procedures, and LOTO procedures *specific* to the RMMPS, will be qualified to perform the steps in this procedure.
- 3.4 All authorized personnel shall be trained on electrical safety specific to the task(s) to be performed, and training documentation shall be kept by Power Supply Systems Section Head.

4. **Precautions**

- 4.1 All personnel shall ensure their own safety by following the standards, safety rules, and the training they receive. In general, all energy sources must be locked out and tagged. Working on or near energized sources, “Working Hot”, is not permitted unless a valid Energized Electrical Work Permit has been issued. Personnel shall utilize tools, instruments, equipment (e.g., proper connectors and proper ac line cords), etc., that are safe and proper for the job. If any part of a job appears unsafe to any individual, it is their duty to discontinue work and inform the supervisor, manager, ESH Coordinator, or the C-AD ESSHQ Division Head, of the unsafe condition.

Warning:

Strict compliance with this procedure, [C-A OPM 2.36 “Lock and Tag Program for Control of Hazardous Energy”](#), and BNL [SBMS Lockout/Tagout \(LOTO\) Subject Area](#), is necessary to avoid fatal or serious injuries to personnel.

4.2 Notification

Notify affected personnel of the action to be taken, in accordance with [C-A-OPM 2.36 “Lock and Tag Program for Control of Hazardous Energy”](#), and BNL [SBMS Lockout/Tagout \(LOTO\) Subject Area](#).

5. **Procedure**

5.1 Companion Documents

5.1.1 These procedures are ONLY to be performed by authorized personnel as defined in Sections 2.1 and 3.2, and only with the RMMPS in a state where LOTO can be safely performed, as indicated by the current operational procedure for the RMMPS. This will shut down the equipment before the LOTO procedure commences.

5.1.2 The requirements of [C-A-OPM 2.36 “Lock and Tagout Program for Control of Hazardous Energy”](#), and BNL [SBMS Lockout/Tagout \(LOTO\) Subject Area](#), shall be followed.

5.2 **Performing LOTO for access to a ring, a valve box, the Interaction Region Power Supplies (IRPS), a RMMPS PM 480 V_{AC} compartment, a RMMPS PM SCR compartment, and all OCC compartments EXCEPT the Hot Box and the Cold Box.**

Table 2 shows the nomenclature used to identify the power modules, disconnect switches, and OCCs.

Caution:

These steps must be performed on BOTH the Flat-Top power module, and the ramp power module for the power supply being LOTO.

5.2.1 Use the ampmeter on the front of the PM to confirm there is zero current into the power module. The power is three phase so the switch below the meter must be used to test all three phases. See Figure 1 in the Appendix.

5.2.2 Use the meter on the front of the PM to confirm the presence of input voltage to the PM. The power is three phase so the switch below the meter must be used to test all three phases. The proper voltage is about 480 V_{AC}. See Figure 1 in the Appendix. This step insures the meter is working.

5.2.3 Check the LED power indicator on the 480 V_{AC} compartment access door on the rear of the power module. See Figure 2 in the Appendix. The three LEDs labeled L1, L2, and L3 should be blinking. The LED labeled GND may be dimly lit, this is normal. If it is as bright as the other LEDs there

may be a ground fault in the input power system. This step insures the power indicator is working.

Caution:

When LOTO is performed on the PM Control Power Switch a tree shall NOT be used, the lock must be applied directly to the switch. The following step requires the appropriate PPE for a class 0+ hazard.

- 5.2.4 The PM Control Power Switches for both the Flat-Top and Ramp PM must be turned OFF. Only the Flat-Top PM Control Power Switch must be LOTO. The Control Power Switch is located on the low voltage compartment door on the front of the PM. See Figure 1 in the Appendix. This switch shuts off the control power to the PM, and Flat-Top switch also turns OFF the UPS power to the OCC Quench SCR Gate Drive Circuit and the OCC PFN circuit.
- 5.2.5 The lights on the chassis located above the Control Power Switch should go off indicating control power has been turned OFF.

Caution:

The appropriate 480 V_{AC} Disconnect Switches must be turned OFF and LOTO. The 480 V_{AC} Disconnect Switches require class 4 Personal Protection Equipment (PPE).

- 5.2.6 There are two switches for each RMMPS, one for the flattop module and one for the ramp module; both switches must be opened when LOTO is applied to a power supply, see Table 3. These switches have a Kirk Key system. The Kirk Keys should be removed from the switches and either placed in a lock box, or placed in the transfer bar associated with the power supply being LOTO. In order to access the 480 V_{AC} compartment of a PM, or the SCR compartment of a PM, the two Kirk Keys associated with a RMMPS must be placed in the transfer bar. The appropriate Kirk Key to open one of these compartments can then be removed from the transfer bar. There are three types of disconnect switches. One type for the Flattop Modules, one type for the Quad Ramp Modules, and one type for the Dipole Ramp Modules. See Figures 3 and 4 in the Appendix. The Flattop and Quad Ramp Module switches are located on the south wall of building 1004B in the hi-bay area. The Dipole Ramp Module switches are located at the end of the ramp PM row near the roll-up door. These switches shut off the 480 V_{AC} to the PM.

- 5.2.7 After the Disconnect Switches are opened the voltage meter on the low voltage compartment door, and the LED power indicator on the 480 V_{AC} compartment access door should be checked to insure the 480 V_{AC} has been disconnected from the power supply.

Note:

Accessing the 480 V_{AC} compartment of a PM requires further verification that the 480 V_{AC} has been disconnected. Steps 5.2.1 through 5.2.7 reduce the hazard to a class 0+, therefore verifying that the 480 V_{AC} is off requires PPE for a class 0+ hazard. When verifying, measurements must be made between all three phases and between all three phases and ground.

5.3 **Performing LOTO for access to the OCC Hot Box.**

- 5.3.1 Check the LEDs on the power panel inside the Hot Box access door. See Figure 5 in the Appendix. All eleven LEDs should be lit. This step insures the LEDs are working.

Caution:

Steps 5.3.2 through 5.3.6 require the appropriate PPE for a class 0+ hazard.

- 5.3.2 Open the circuit breakers labeled CB1 through CB5 located within the Hot Box. See Figure 6 in the Appendix. There is no need to LOTO these breakers; LOTO applied to the breakers in the following steps removes the power to the line side of these breakers. This step is to insure an orderly shutdown. This shuts OFF power to the Regulator Chassis, remote I/O PLC, PFN circuits, Quench Interface Circuit, and the Current Monitor Circuit.
- 5.3.3 Check the LEDs on the power panel inside the Hot Box access door. All eleven LEDs should be OFF (Figure 5) .
- 5.3.4 Open and LOTO the appropriate circuit breaker located in the Blue Dipole Flat-Top Power Module, these are labeled CB 9 – CB 16. See Table 4 and Figure 7 in the Appendix. This step requires the appropriate PPE for a class 0+ hazard. This step shuts OFF the UPS power in the OCC.
- 5.3.5 Open and LOTO the appropriate circuit breaker, according to Table 4, located in electrical service box labeled “Panel # P4BRP4”. Only open the 115 V_{AC} breaker at this step. See Figure 8 in the Appendix. This circuit breaker shuts off the house 115 V_{AC} to the OCC.

- 5.3.6 Wait about two minutes for the heatsinks on the Cold Box to cool, then open and LOTO the 208 VAC ganged breakers, according to Table 4, located in electrical service box labeled “Panel # P4BRP4”. This step shuts OFF the three phase 208 VAC to the OCC.

5.4 **Performing LOTO for access to the OCC Cold Box.**

- 5.4.1 Check the LEDs on the power panel inside the Hot Box access door. See Figure 5 in the Appendix. All eleven LEDs should be lit. This step insures the LEDs are working.

Caution:

When LOTO is performed on the PM Control Power Switch, a tree shall NOT be used, the lock must be applied directly to the switch.

- 5.4.2 The Flat-Top PM Control Power Switch must be turned OFF and LOTO. The Control Power Switch is located on the low voltage compartment door on the front of the PM. See Figure 1 in the Appendix. This switch shuts OFF the control power to the PM, and the UPS power to the OCC Quench SCR Gate Drive Circuit and the OCC PFN circuit.

Caution:

Steps 5.4.3 through 5.4.5 require the appropriate PPE for a Class 0+ hazard.

- 5.4.3 Open the circuit breaker labeled CB 5 located within the Hot Box. See Figure 6 in the Appendix. This shuts OFF power to the regulator. There is no need to LOTO this breaker; the next step removes power from the line side of this breaker. This step insures an orderly shut-down.
- 5.4.4 Open and LOTO the appropriate circuit breaker located in the Blue Dipole Flat-Top Power Module low voltage compartment. See Table 4 and Figure 7 in the Appendix. This shuts OFF the UPS power in the OCC, removing power from the DCCT and CB 5.
- 5.4.5 Open and LOTO the appropriate 115 V_{AC} circuit breaker, according to Table 4, located in electrical service box labeled “Panel # P4BRP4”. See Figure 8 in the Appendix. This circuit breaker shuts off the house 115 V_{AC} to the OCC, removing power to the Redundant DCCT and the HP voltmeter.
- 5.4.6 Check the LEDs on the power panel inside the Hot Box access door. See Figure 5 in the Appendix. All eleven LEDs should be OFF.

5.5 **Removing LOTO after access to a ring, a valve box, the Interaction Region**

Power Supplies (IRPS), RMMPS 480 V_{AC} compartment, a RMMPS PM SCR compartment, or any OCC compartments except the Hot Box and the Cold Box.

Caution:

The following action, paragraph 5.5.2 requires PPE appropriate for a class 4 hazard.

- 5.5.1 Verify all panels are installed and doors are closed on the RMMPS.
- 5.5.2 Remove LOTO from the switches in paragraph 5.2.6 and close the switches.
- 5.5.3 Use the meter on the front of the PM to confirm the presence of input voltage to the PM. The power is three phase so the switch below the meter must be used to test all three phases. This step requires the appropriate PPE for a class 0+ hazard. The proper voltage is about 480 V_{AC}.
- 5.5.4 Check the LED power indicator on the 480 V_{AC} compartment access door on the rear of the power module. See Figure 2 in the Appendix. The three LEDs labeled L1, L2, and L3 should be blinking. The LED labeled GND may be dimly lit, this is normal. If it is as bright as the other LEDs there may be a ground fault in the input power system.

Caution:

The following action, paragraph 5.5.5 requires PPE appropriate for a class 0+ hazard.

- 5.5.5 Remove LOTO from the switches in paragraph 5.2.4 and close the switches.
- 5.5.6 The lights on the chassis located above the Control Power Switch should go ON indicating control power has been restored.

5.6 **Removing LOTO after access to the OCC Hot Box.**

- 5.6.1 Verify all panels are installed and doors are closed on the RMMPS.

Caution:

Steps 5.6.2 through 5.6.4 require PPE appropriate for a class 0+ hazard.

- 5.6.2 Remove LOTO from the switches in paragraphs 5.3.5 and 5.3.6 and close the switches. Check the Sorenson power supply in the Hot Box to insure it is operating normally. There should be two green lights, and no red lights

lit. If a red light is lit put the power supply in standby mode momentarily using the S/D push-button, and then back to operational mode by pressing the S/D push-button again. See Figure 9 in the Appendix.

- 5.6.3 Remove LOTO from the switches in paragraphs 5.3.4 and close the switches.
- 5.6.4 Close the switches opened in paragraph 5.3.2.
- 5.6.5 Press the PLC Reset Button on the front of the OCC. See Figure 10 in the Appendix.
- 5.6.6 Check the LEDs on the power panel inside the Hot Box access door. See Picture 5 in the Appendix. All eleven LEDs should be lit.

5.7 **Removing LOTO after access to the OCC Cold Box.**

- 5.7.1 Verify all panels are installed and doors are closed on the RMMPS.

Caution:

Steps 5.7.2 through 5.7.5 requires PPE appropriate for a class 0+ hazard.

- 5.7.2 Remove LOTO from the switches in paragraph 5.4.5 and close the switches. Check the Sorenson power supply in the Hot Box to insure it is operating normally. There should be two green lights, and no red lights lit. If a red light is lit put the power supply in standby mode momentarily using the S/D push-button, and then back to operational mode by pressing the S/D push-button again. See Figure 9 in the Appendix.
- 5.7.3 Close the switches opened in paragraph 5.4.4.
- 5.7.4 Close the switch opened in paragraph 5.4.3.
- 5.7.5 Remove LOTO from the switch in paragraph 5.4.2 and close the switch.
- 5.7.6 Press the PLC Reset Button on the front of the OCC. See Figure 10 in the Appendix.
- 5.7.7 Check the LEDs on the power panel inside the Hot Box access door. See Figure 5 in the Appendix. All eleven LEDs should be lit.

6. Documentation

- 6.1 Power Supply Section (PSS) Activities Logbook
- 6.2 LOTO Logbook located in Power Supply Shop in 911.

7. References

- 7.1 [C-A-OPM 1.5, "Electrical Safety Implementation Plan"](#).
- 7.2 [C-A-OPM 1.5.3 "Procedure to Open or Close Breakers and Switches and Connecting/Disconnecting Plugs"](#).
- 7.3 [C-A-OPM 2.36, "Lockout/Tagout for Control of Hazardous Energy"](#).
- 7.4 [SBMS Electrical Safety.](#)
- 7.5 [SBMS Lockout/Tagout \(LOTO\).](#)

8. Attachments

None

TABLE 2 RMMPS NOMENCLATURE

POWER SUPPLY	FLAT-TOP POWER MODULE	RAMP POWER MODULE	OCC
BLUE DIPOLE	PBDFT	PBDR	RBD OCC
BLUE QUAD	PBQFT	PBQR	RBQ OCC
YELLOW DIPOLE	PYDFT	PYDR	RYD OCC
YELLOW QUAD	PYQFT	PYQR	RYQ OCC

TABLE 3 480 V_{AC} DISCONNECT SWITCHES NOMENCLATURE

POWER SUPPLY	FLAT-TOP POWER MODULE	RAMP POWER MODULE
BLUE DIPOLE	SBDFT	SBDR
BLUE QUAD	SBQFT	SBQR
YELLOW DIPOLE	SYDFT	SYDR
YELLOW QUAD	SYQFT	SYQR

TABLE 4 CIRCUIT BREAKERS

POWER SUPPLY		CIRCUIT BREAKER PANEL P4BRP4 CIRCUIT #		(inside Blue Dipole Flat-Top) UPS CIRCUIT BREAKER #
		115 V_{AC}	Ganged Breakers 208 V_{AC}	
BLUE DIPOLE	OCC	8	2, 4, 6	16
	RPM			9
	FTPM			11
BLUE QUAD	OCC	22	16, 18, 20	14
	RPM			9
	FTPM			11
YELLOW DIPOLE	OCC	13	7, 9, 11	15
	RPM			10
	FTPM			12
YELLOW QUAD	OCC	23	17, 19, 21	13
	RPM			10
	FTPM			12

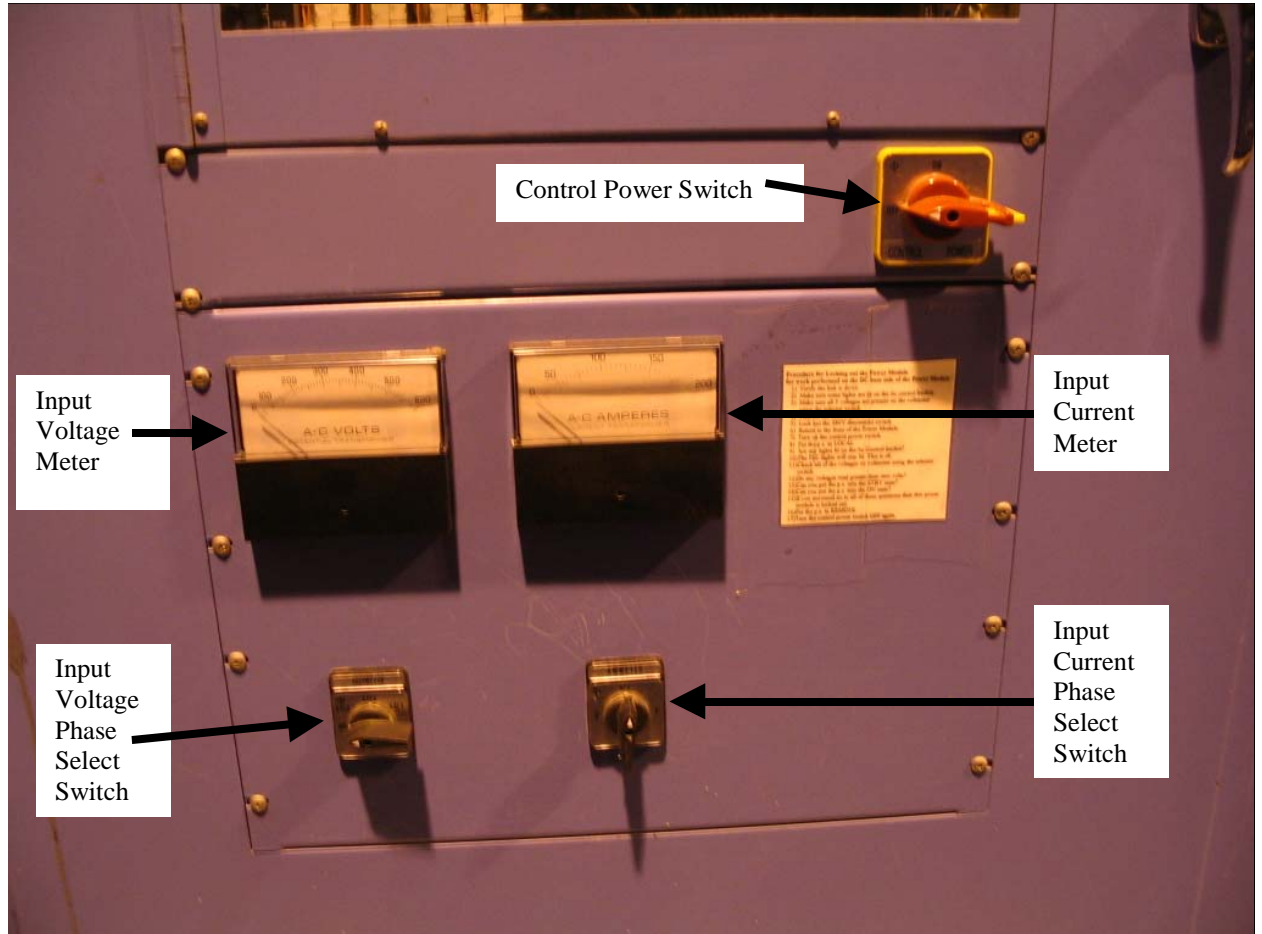


Figure 1 Power Module Meter and Switch



Figure 2 LED Power Indicator on 480 Vac Compartment Access Door



Figure 3 "Small" Disconnect Switches



Figure 4 Dipole Ramp Disconnect Switches

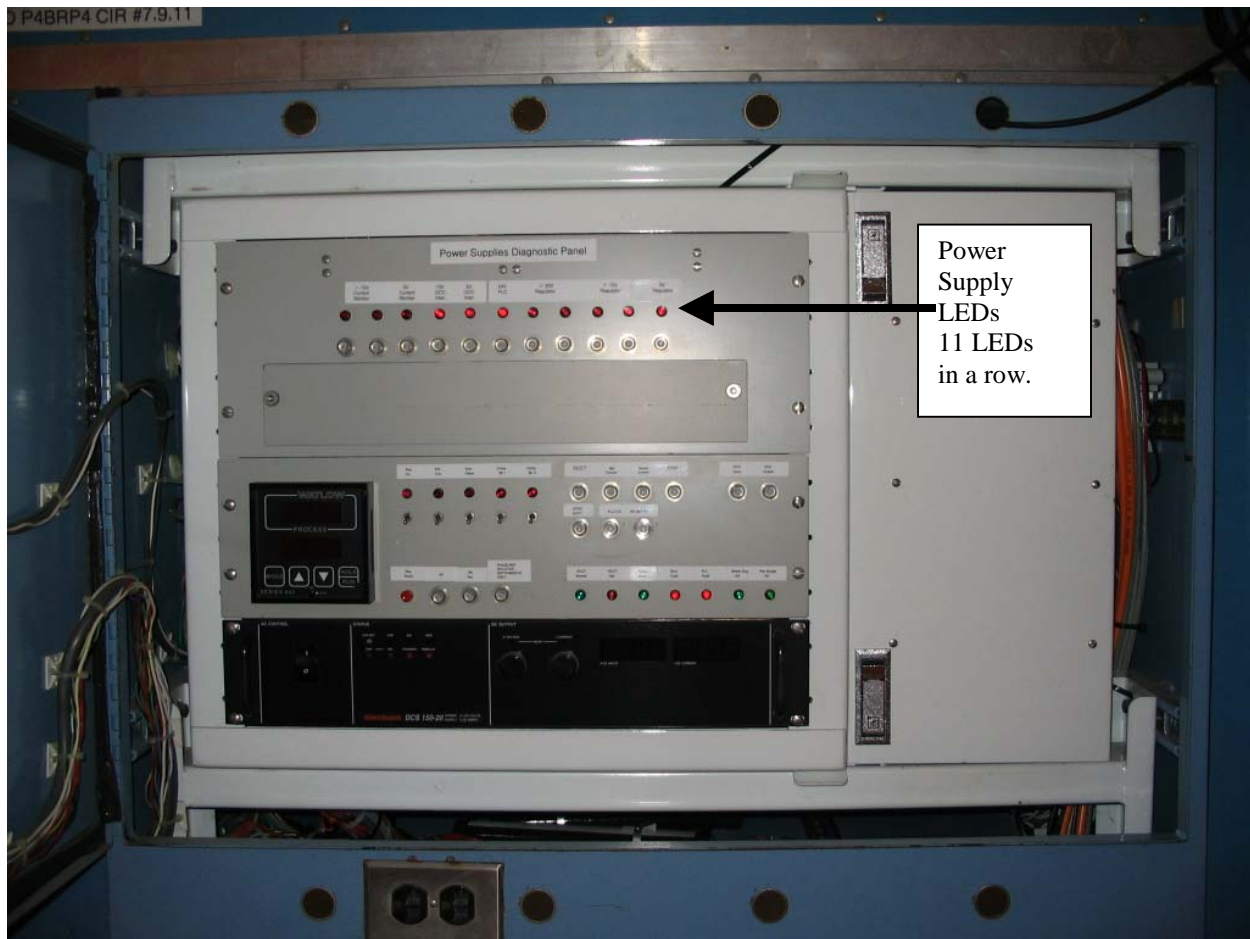


Figure 5 Hot Box Inner Panel

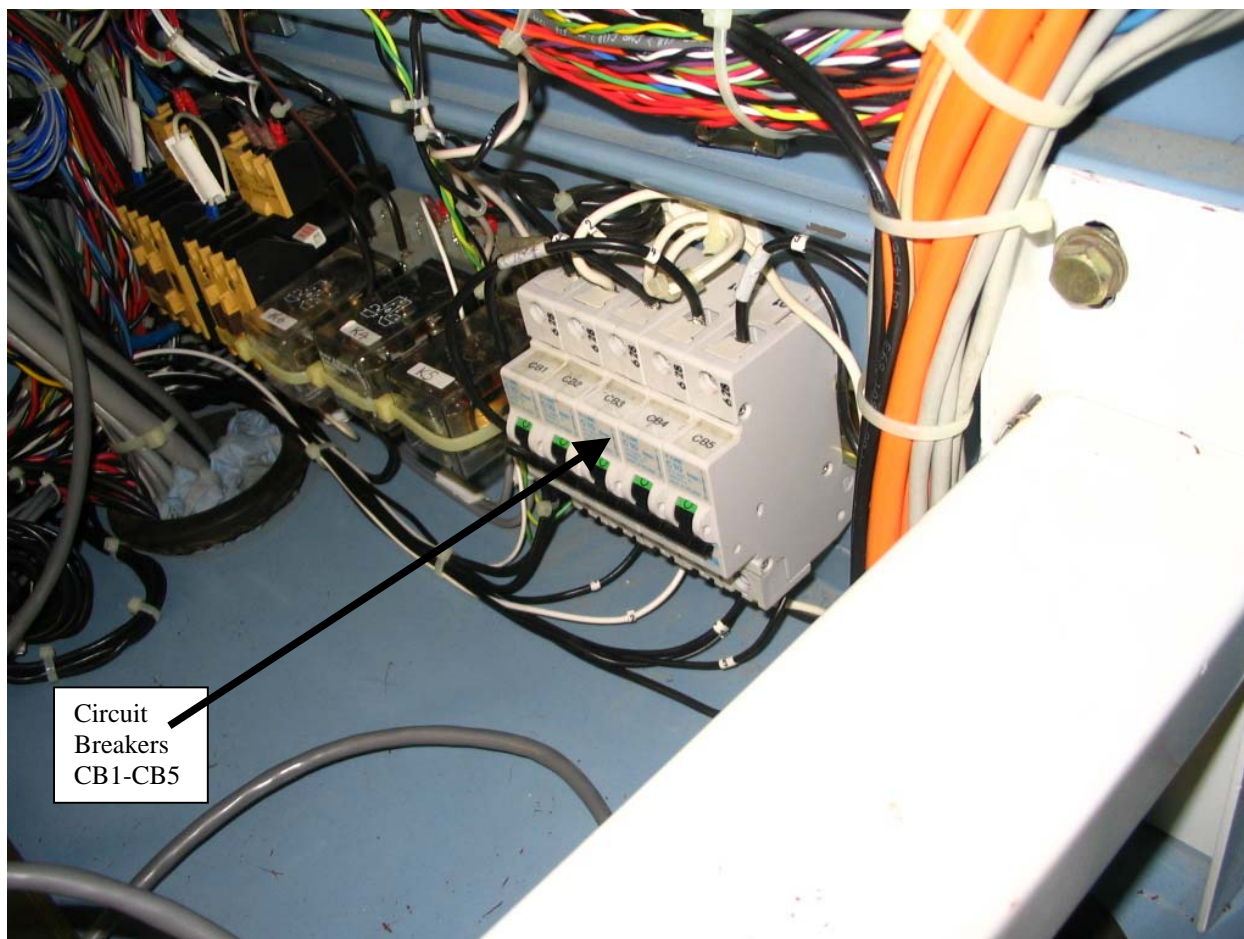


Figure 6 Hot Box Circuit Breakers

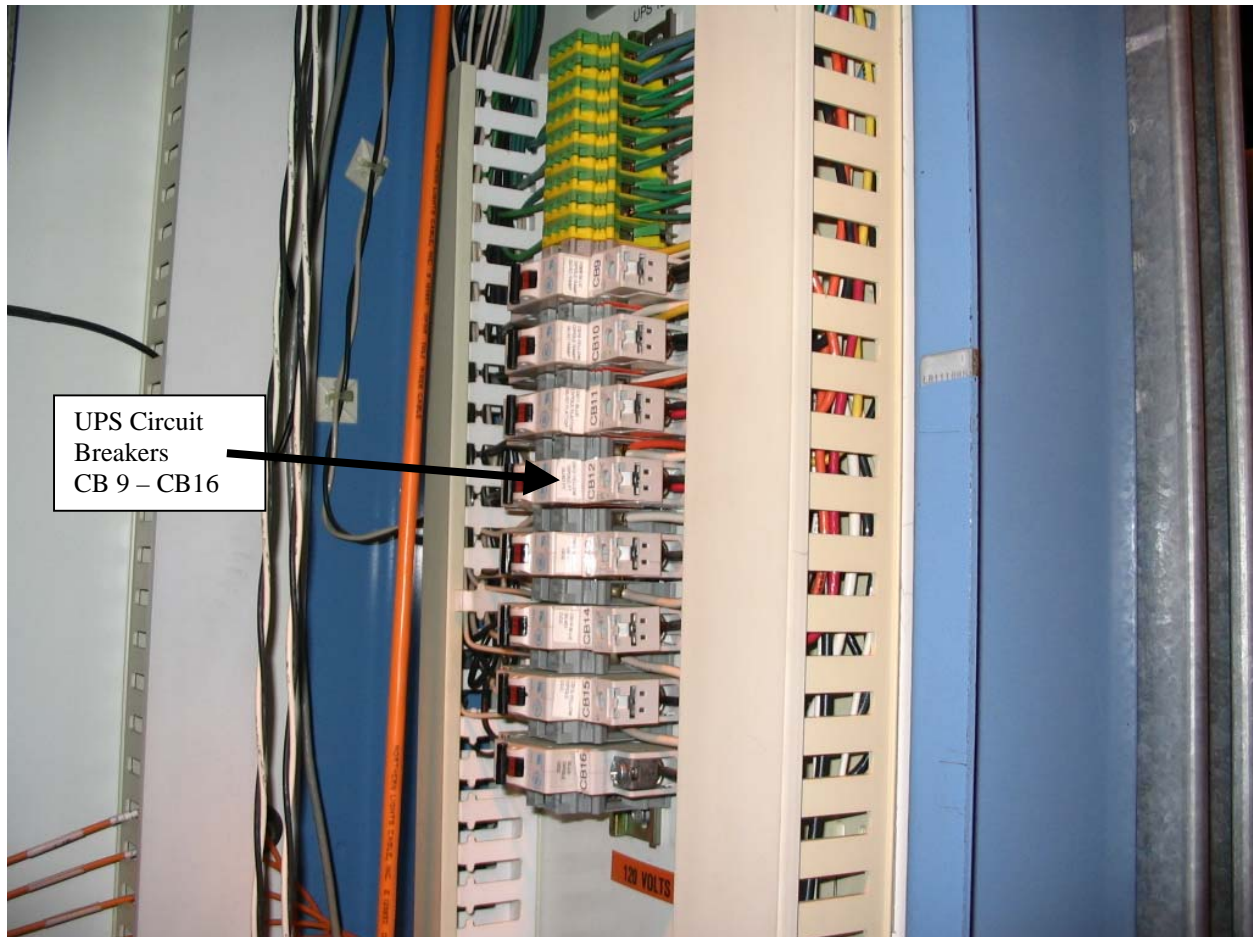


Figure 7 UPS Breakers in Blue Dipole FTPM



Electrical
Panel
P4BRP4

Figure 8 Electrical Panel P4BRP4

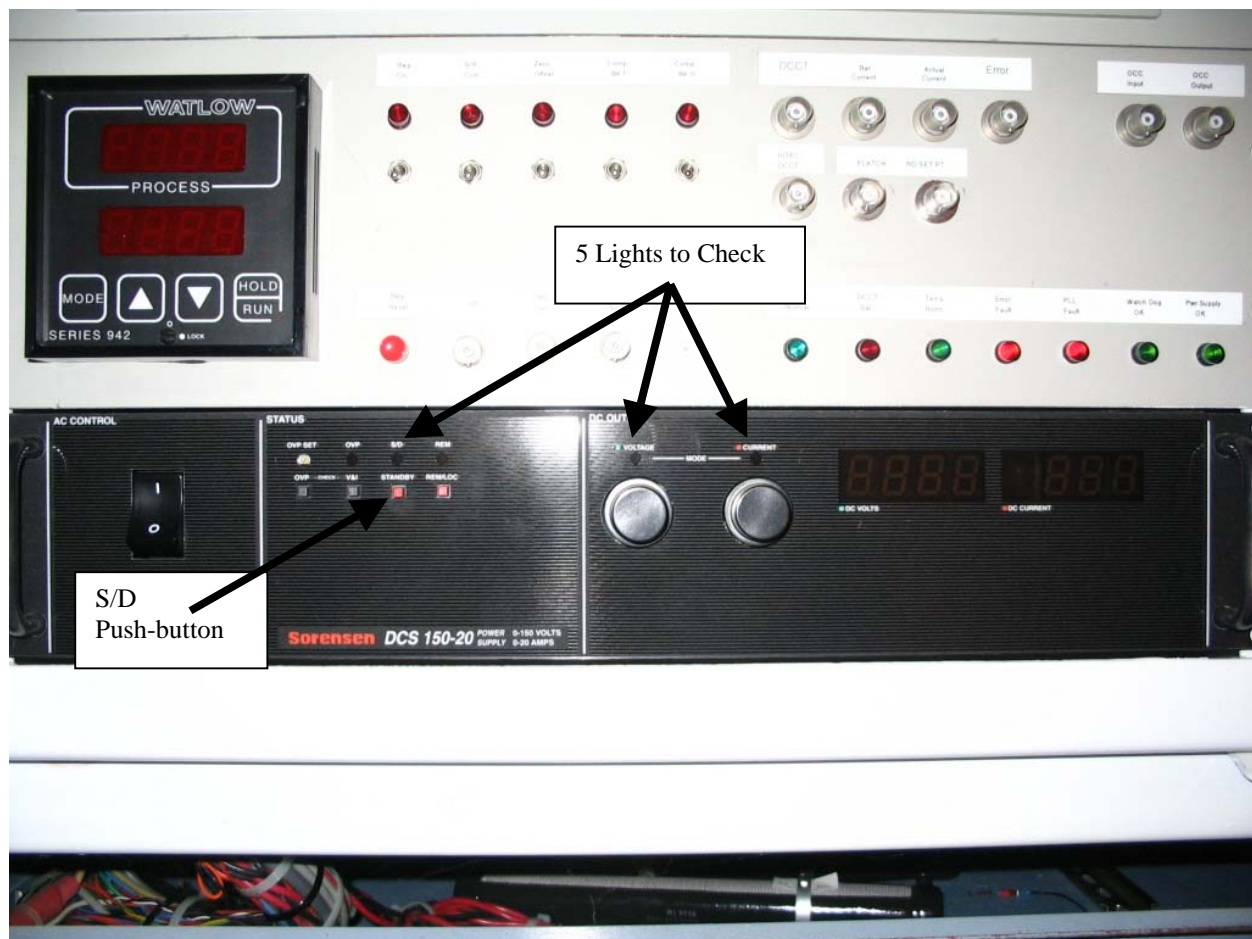


Figure 9 Sorenson Power Supply in Hot Box

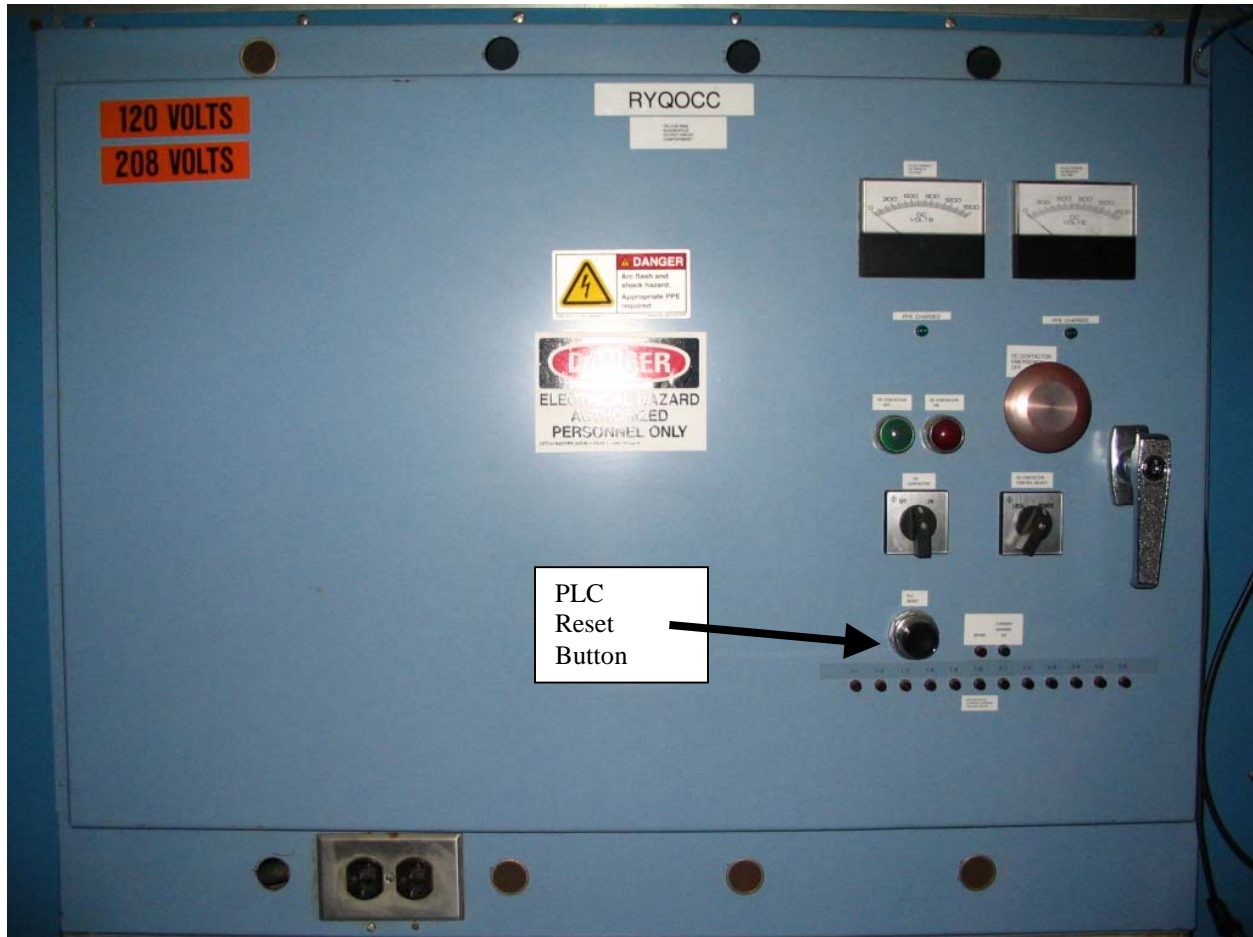


Figure 10 Outside Door of Hot Box